Arsenic Removal Using Amended Silicates™

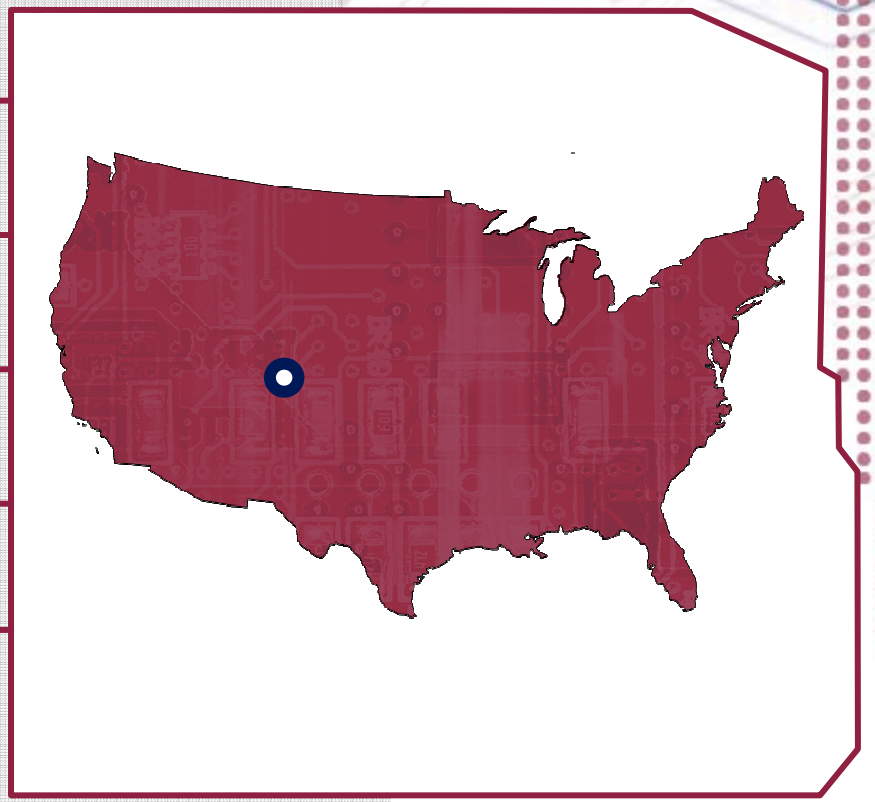
Albuquerque, New Mexico
November 2, 2005

ADA Technologies, Inc.

Taking Today's Technologies into Tomorrow's Markets

ADA Technologies …Who are we?

- 20 years in Littleton, CO
- $35m contract research
- 17 patents issued, 6 pending
- 35 staff – 5 PhDs
- Diverse R&D technical areas



TOP COMPANY
COLORADO'S MOST COMPETITIVE BUSINESS AWARD
2005

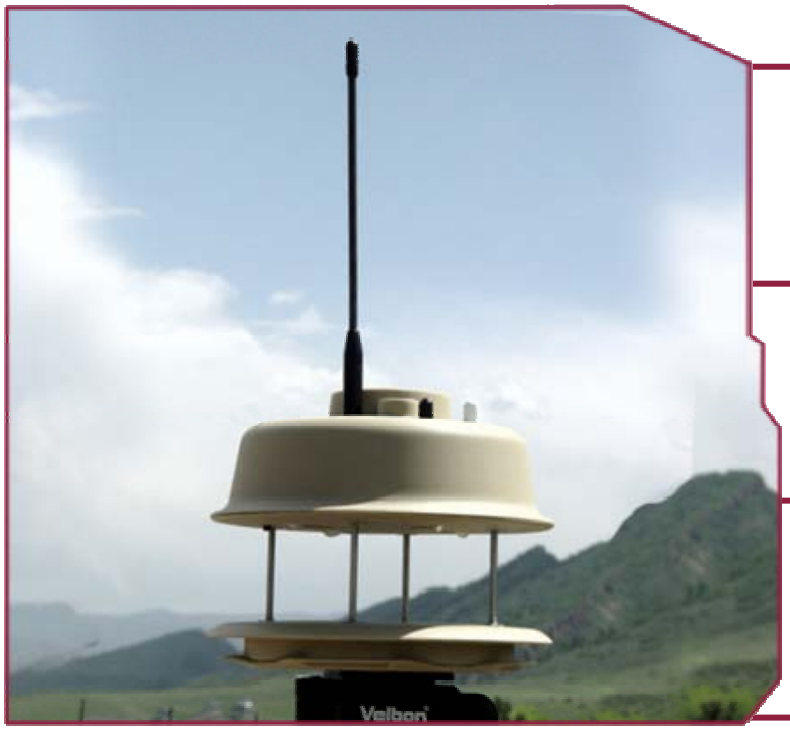
Expertise

Mercury & Toxic Metals

PhysioNetics®

Instruments & Sensors

Channels to Market



Joint venture

Licenses

Spin off

Sell

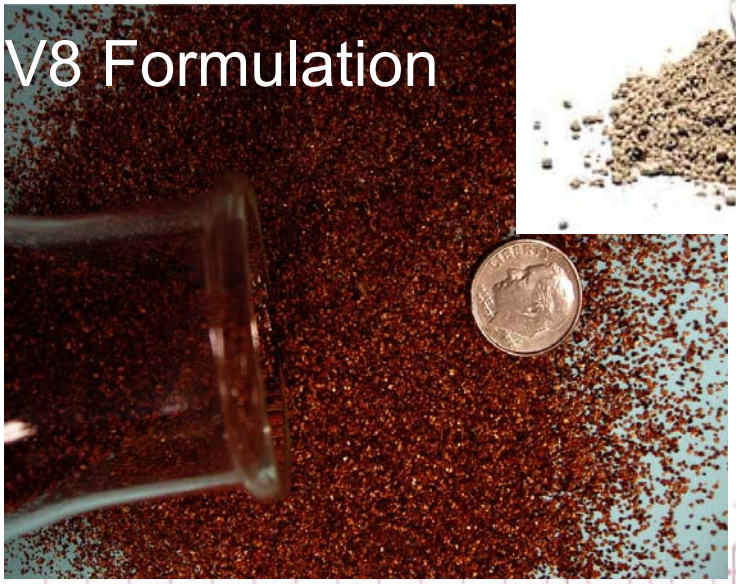
Arsenic Removal
Research & Development

ADA Technologies, Inc.

Taking Today's Technologies into Tomorrow's Markets

ADA's Amended Silicates™

- Developed under SBIR funding
- Made by chemically modifying an inexpensive silicate substrate
- Process can be tailored for specific contaminates (for example, Hg or As)

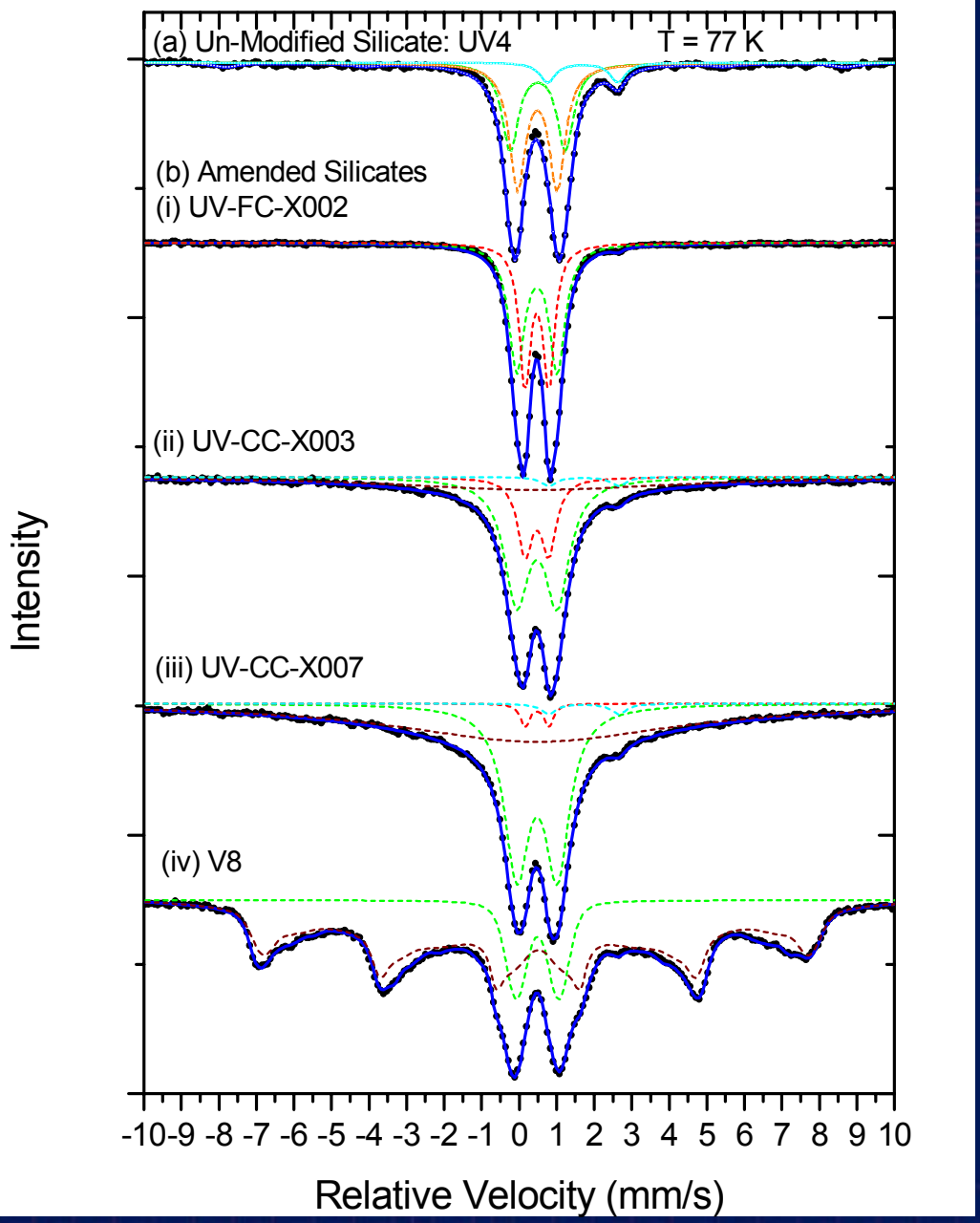


ADA Arsenic Treatment R&D

Agency	Major Focus
EPA Phase I & II	• Sorbent development • Fabrication and testing of POU system. • As sensor development
NIEHS Phase I & II	• Sorbent chemistry fundamentals and development • Pilot study focused on fluidized system
US Air Force Phase I & II	• Beaded sorbent development • Electrocoagulation/filtration arsenic capture • Pilot testing focused on packed columns
State of Colorado	• Testing of Amended Silicate™ sorbent at Alamosa, CO

V8 Formulation Physical Properties

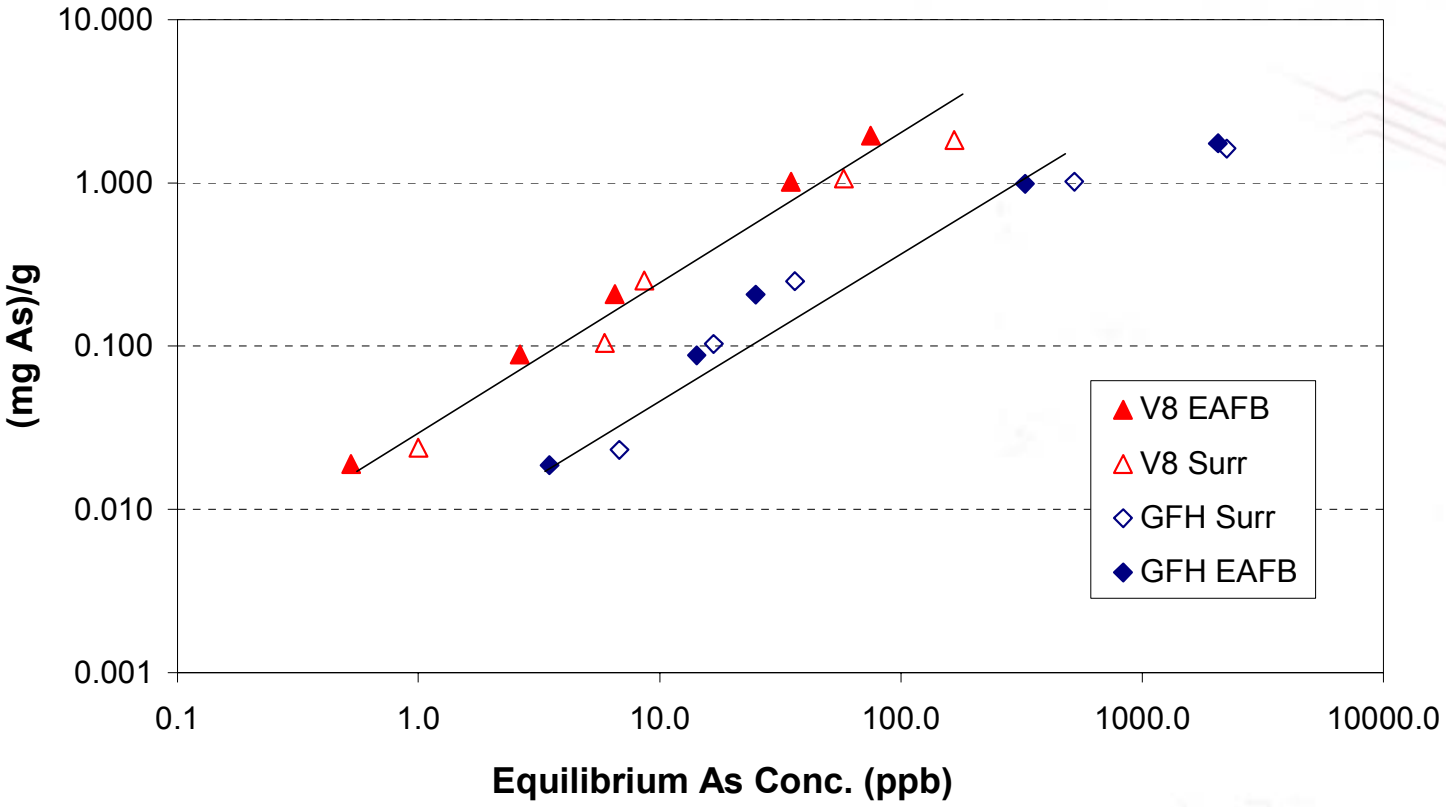
Property	V8 Amended Silicate™	GFH	AdEdge AD33
Surface Area	82 m^2/g (BET)	242-290 m^2/g (BET)	119-140 m^2/g (BET)
Bulk Density	~0.3 kg/L	1.25 kg/L	0.45 kg/L
Particle size	-10/+45 mesh (for packed bed)	-8/+65 mesh	-10/+35 mesh
Iron Content	~25%	36%	57%
Water Content	~5%	43-48%	<15%
Iron Phase	nano-scale Akaganeite	Akaganeite & ferrihydrite	Goethite



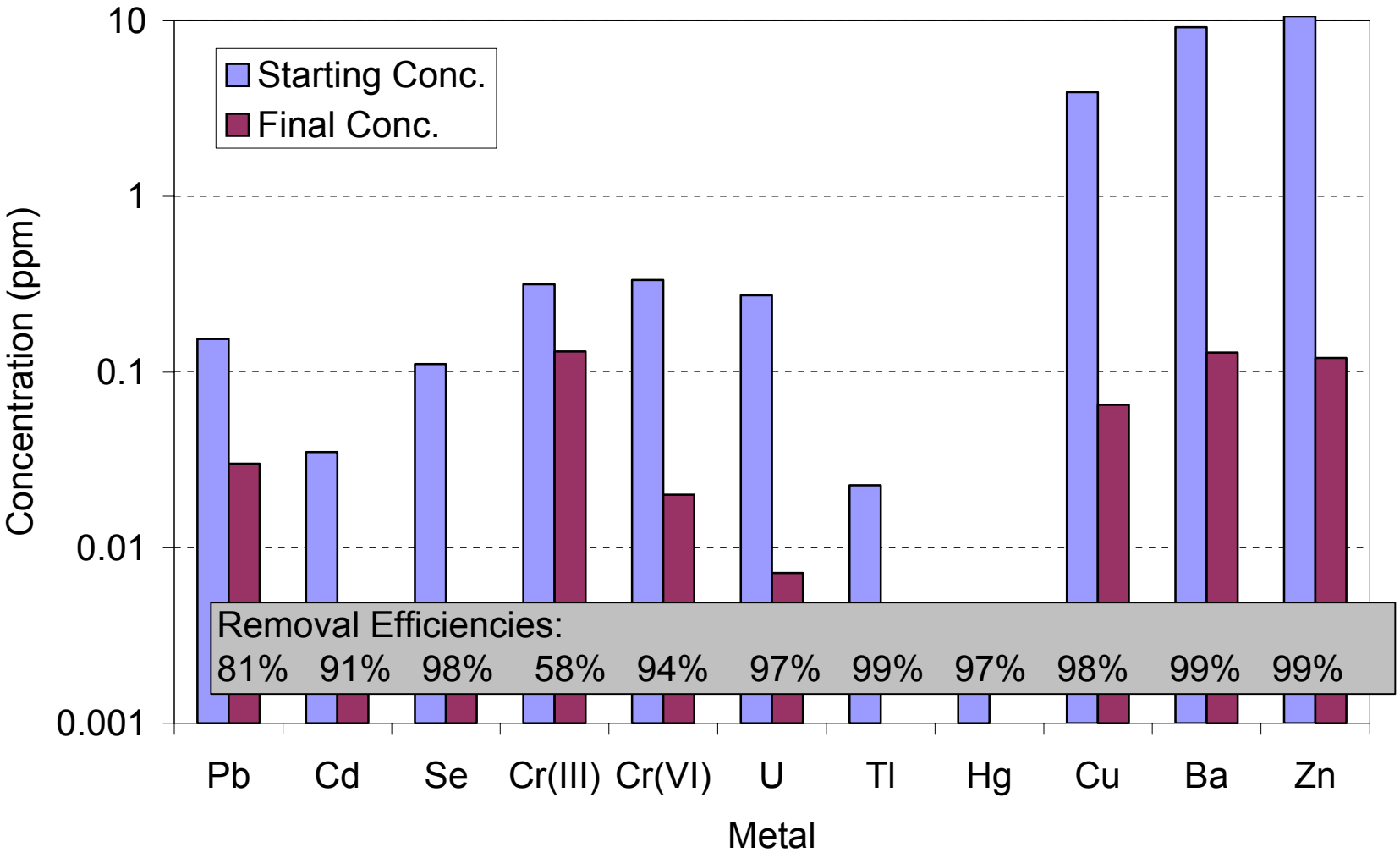
V8 formulation shows Mössbauer signature of akaganeite – the desired iron phase.

V8 Amended Silicate™ Performance

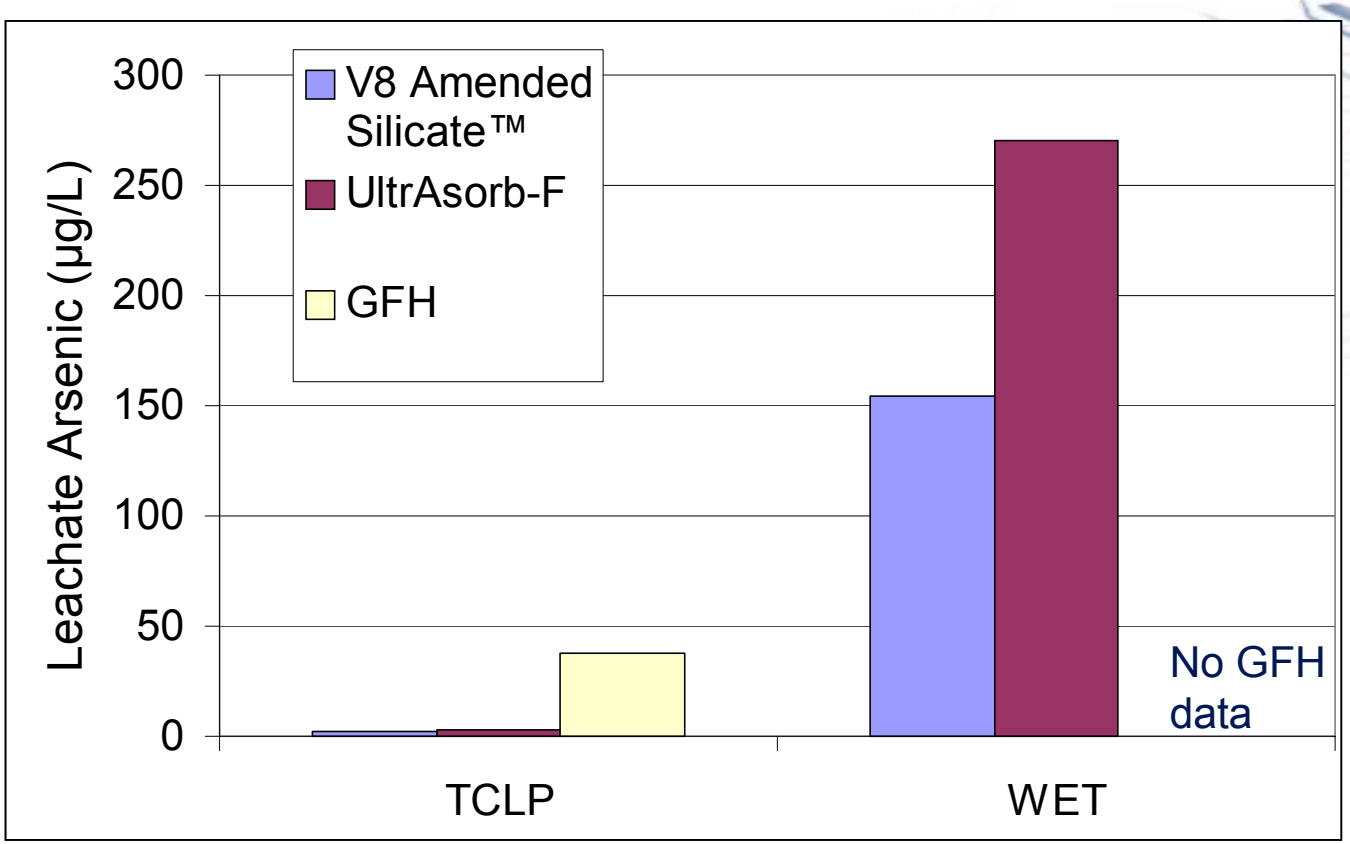
Amended Silicate™ outperforms GFH in isotherm tests



Amended Silicates™ Captures other Metals



Amended Silicates™ easily passes Leaching Tests



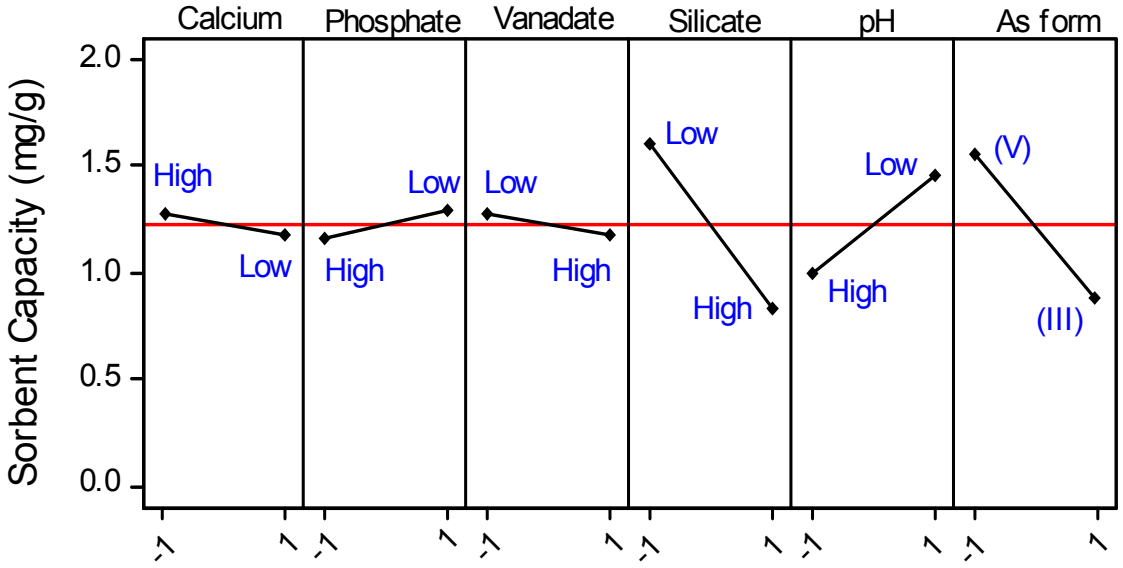
The leachates from the WET and TCLP tests are well below the allowable soluble threshold limit of 5,000 µg/L

Parametric Examination of Water Constituents

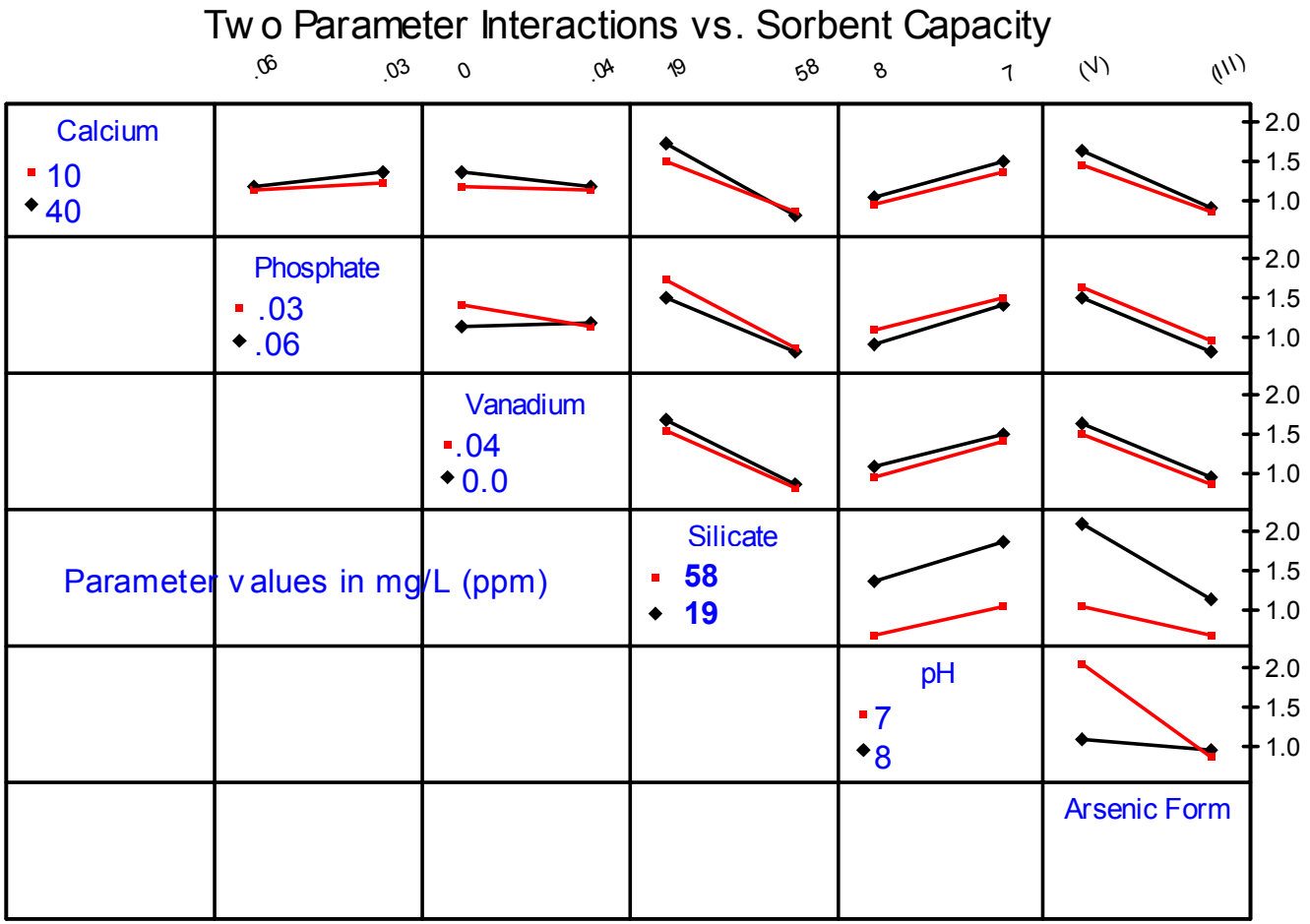
Arsenic Challenge water used as base case composition.

Parameter, mg/L except pH	Base case, (-)	Variant, (+)
Calcium	40	10
Phosphate (as P)	0.06	0.03
Vanadium (as V)	0	0.04
pH	8.0	7.0
Silica (as SiO_2)	19	58
Arsenic form	arsenate	arsenite

Significant primary effects on sorbent capacity by silicate, pH, and arsenic form.



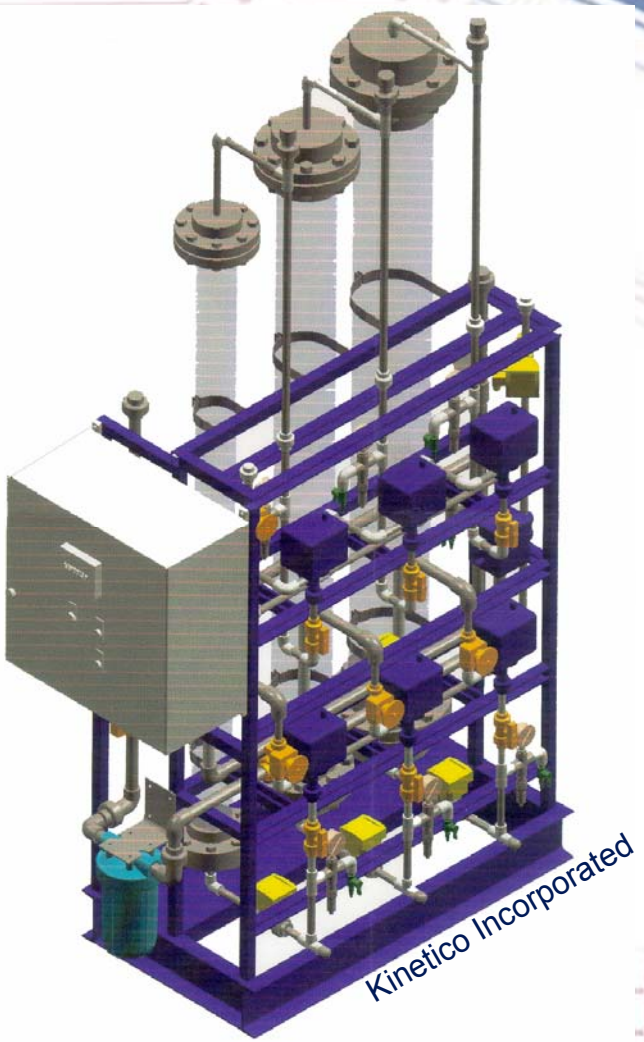
Interactions between Water Components



Lowering pH improves As(V) capture, but does little for As(III) capture.

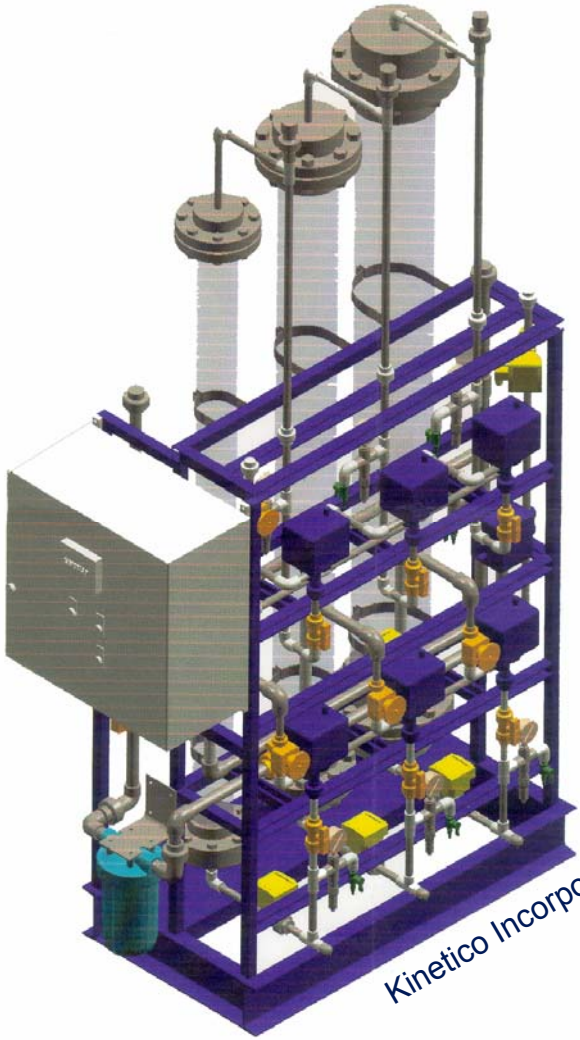
Packed Bed Pilot Testing

- Pilot testing in ADA's labs with water designed to mimic southern California aquifer



Packed Bed Pilot Design

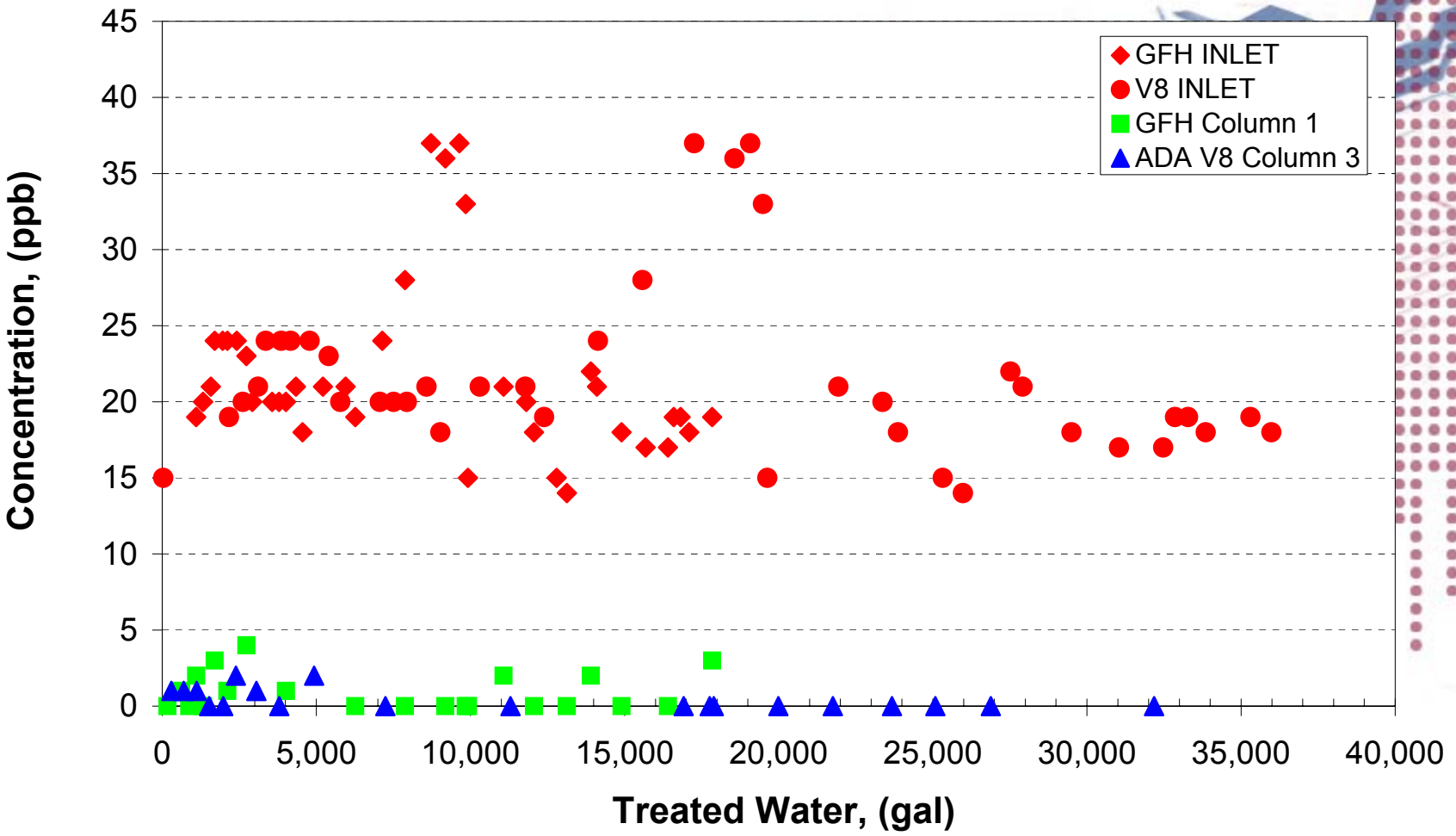
Column	1	2	3
	GFH	Beaded Amended Silicate™	V8 Amended Silicate™
Diameter (inch)	4	6	8
Media Height (ft)	3.50	3.50	3.50
Flow Rate (GPM)	0.45	1.0	1.0
Freeboard Factor	1.5	1.5	1.5
Column Height (ft)	6	6	6
Cross Sectional Area (ft^2)	0.09	0.20	0.34
Media Volume (ft^3)	0.30	0.69	1.20
EBCT (min)	5	5	9
Hydraulic loading (gpm/ft^2)	5	5	3
Density (lb/ft^3)	72	37	18
Sorbent Weight (lb)	22	25	22



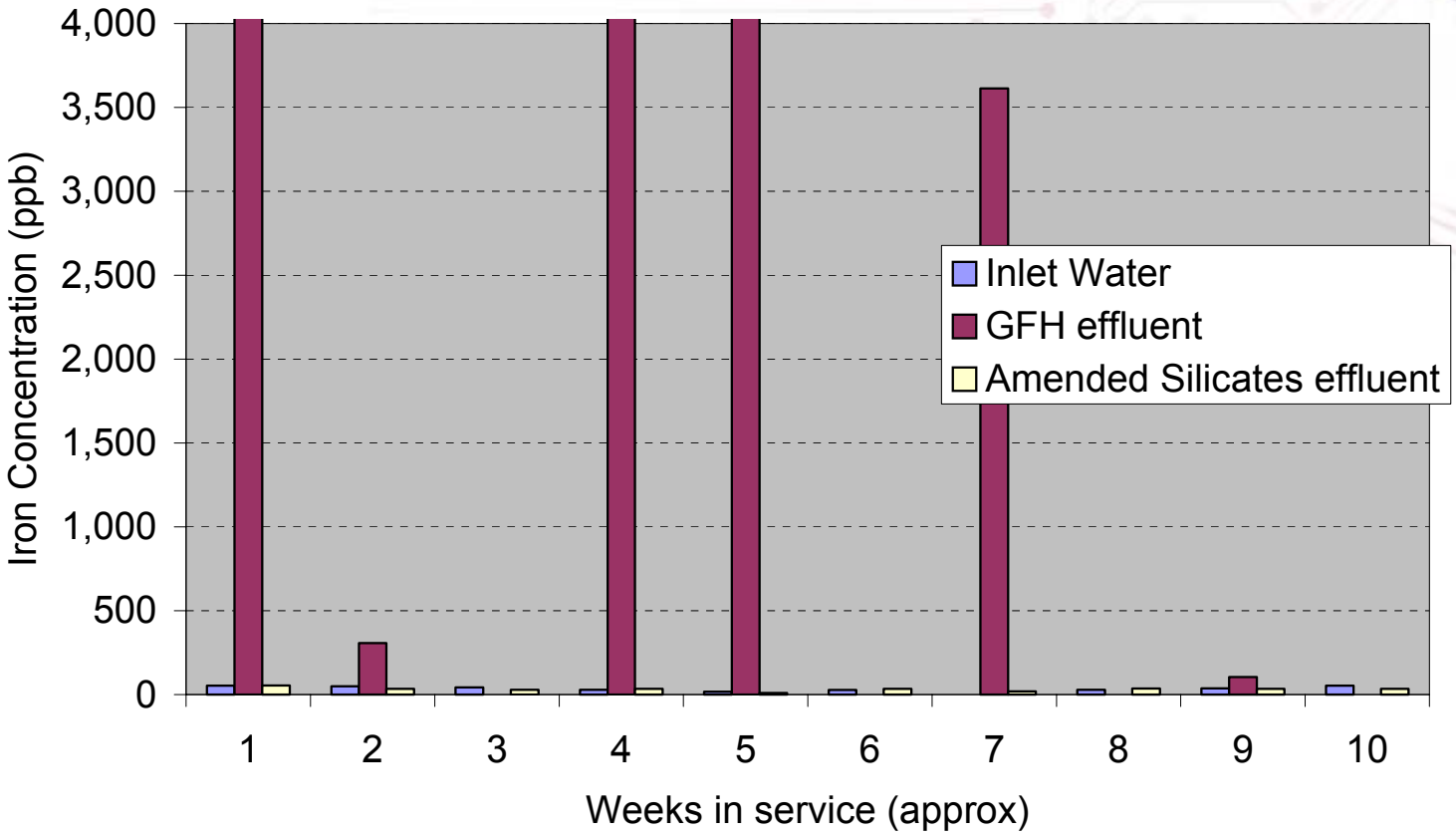
Comparison of Actual and Surrogate EAFB water

Parameter	EAFB Water (mg/L)	Surrogate Water (mg/L)
Magnesium	3	6
Sodium	53	44
Potassium	3	2.4
Manganese	0	0.02
Calcium	27	28
Sulfate	70	70
Nitrate	0.4	0.2
Phosphorus (as P)	0.02	0.03
Carb/bicarbonate	120	62
Silica (as SiO2)	35	23
Chloride	23	47
Arsenic, As(V)	0.017	0.022
pH	8.0	8.0

Pilot Test – Arsenic Data

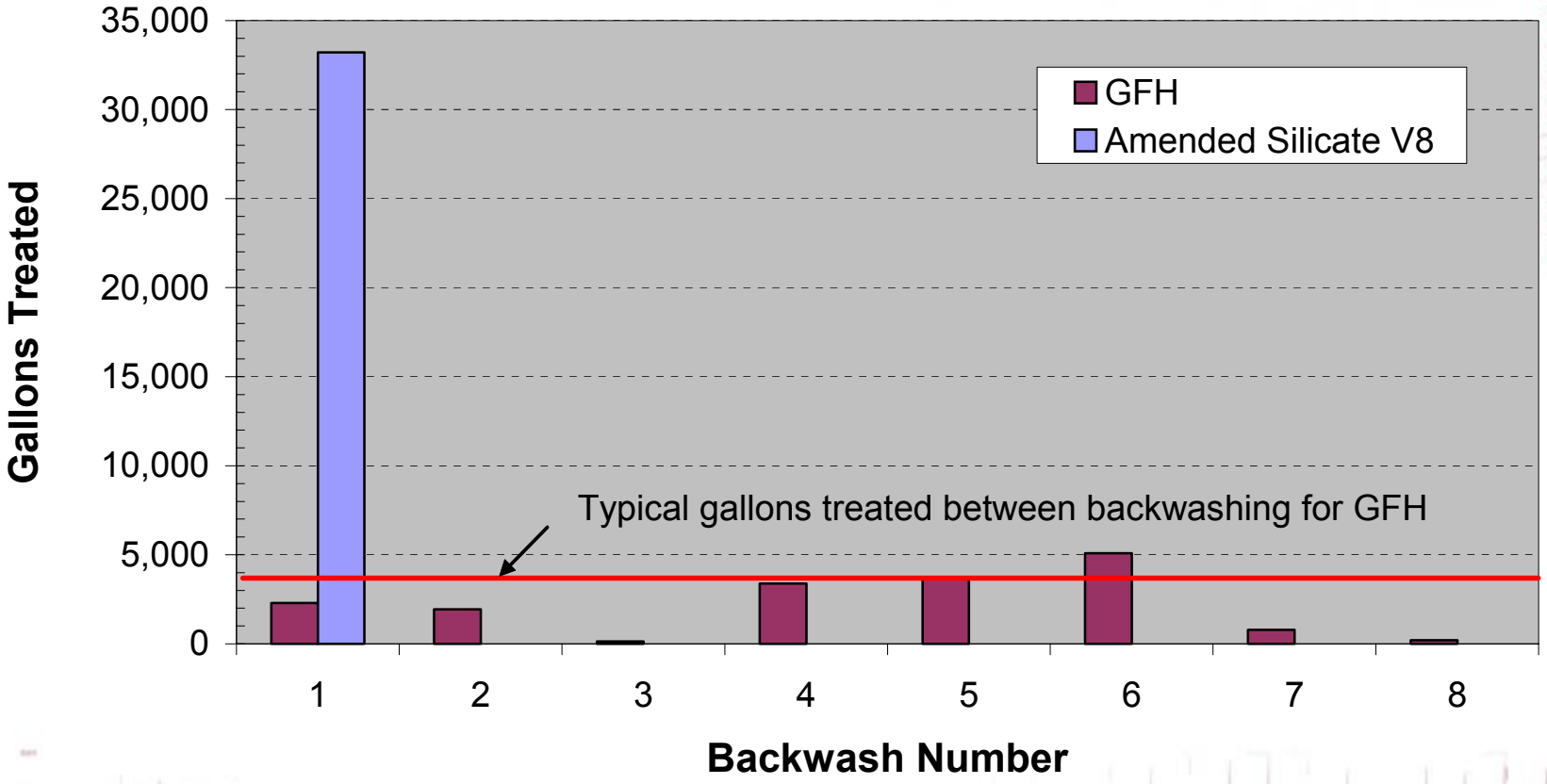


Pilot Test – Iron in Effluent



Pilot Test – Backwashing

Amended Silicate requires fewer backwashes.



Summary - Attributes of Amended Silicates™

- Easy to produce
- Low cost – cheap substrate with efficiently distributed iron
- Good performance – shares benefits of all iron-based adsorbents for arsenic capture
- Low bulk density
  - ease to fluidize, or
  - short, fat packed bed
  - creates low hydraulic loading, long EBCT
  - Sensitive to pressure shocks

Ongoing Activities

- Start up of pilot test in Castleford, ID
- Completion of parametric evaluation regarding the impact of water quality parameters
- Investigating potential to produce and use Amended Silicates™ in developing countries

Acknowledgements

- US EPA
- US Air Force Flight Test Center, Edwards AFB
- National Institute of Environmental Health Sciences
- State of Colorado
- Sandia National Laboratories
- Kinetico Incorporated
- Virginia Tech University